Unit 8

Electromechanical Assembly

Introduction

Electromechanical assembly converts electrical signals to mechanical movements and vice versa as shown in Fig. 8.1. Electromechanical devices perform electrical operations by movement of different parts. An electromechanical assembly includes electrical and mechanical components. They also involve mechanical and electrical process. A manually operated switch is an electromechanical component, which causes an electrical output due to mechanical movement. Electromechanical assembly is a term, usually, used to refer to devices that involve an electrical signal to create mechanical movement or vice versa. Electromechanical assembly follows electromagnetic principles. For example, in relays, voltage can be controlled by switching the contact using electromagnetic force.

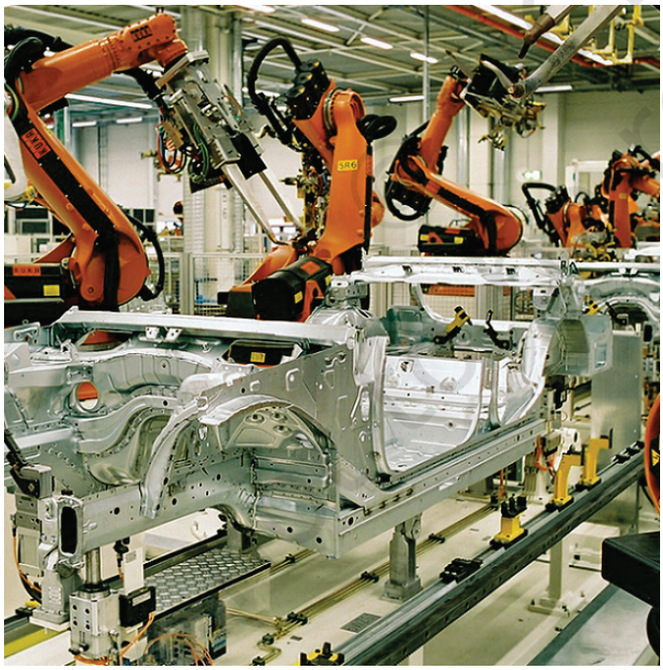

Fig. 8.1 Assembly line in the automobile industry uses electromechanical assembly

Fig. 8.2 Assembly line uses robotic arm for manufacturing unit

Electromechanical system

The term electromechanical indicates conversion of an electrical signal to mechanical movements and vice versa.

Electromechanical systems engineering focusses on things that make electrical and mechanical systems work together. Here, comes the concept of electromechanical assembly, which combines both electrical and mechanical components, and sometimes, electronic components as well.

Electromechanical systems engineers work on ways to make electricity work well with machines. Common electromechanical components, such as electric motors and solenoids are used in combination with mechanical parts to provide actuation or movement. An actuator is a device that converts an electrical signal to mechanical actions. It can create a force to manipulate itself, other mechanical devices or the surrounding environment to perform useful functions.

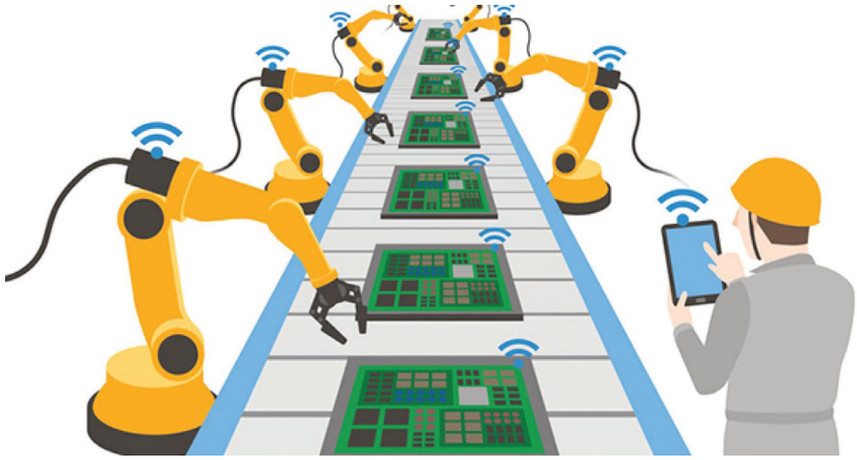

Fig. 8.3 Industrial electromechanical assembly

Fig. 8.4 Electrical control panel cabinet

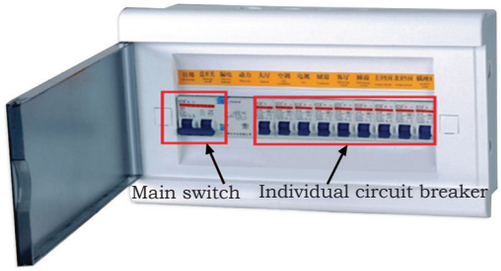

Fig. 8.5 Distribution box

Electromechanical devices or systems, such as electric typewriters and clocks are extensively used in complicated systems, Figs. 8.3 and 8.4 represent an assembly of industrial equipment and an electrical control panel cabinet. Some of the devices and appliances that use electromechanical system are motor vehicles, lifts, cranes, escalators, etc.

Know more...

A control relay is the simplest electrical control device. It has a coil that can be energised (logical 1) and de-energised (logical 0) by voltage (120V, 24V DC) and contacts that change logic state based on its coil (logic input) state. Control relays are used to turn other devices like contactors, pilot lights, etc., on and off.

Assignment 1

- From your daily life, give three examples of appliances that use electromechanical system.

Electromechanical assembly

Electromechanical assemblies provide a customised solution for doing a specific job and having the required output. For example, distribution board of electricity supply (Fig. 8.5) is an electromechanical assembly that contains cables and electromechanical components, such as circuit breakers, fuses, switches, and so on. Some of the common components used in electromechanical assembly are as follows.

- Switch-sensor assembly
- Power supply assembly
- Panel assembly
- Transformer assembly
- Indicator assembly

Components of an electromechanical assembly

Components of an electromechanical assembly are relay, switch, contactor, motor, generator, transformer, PLC, diode, resistor, capacitor, transistor, and so on. Few components, such as circuit boards, control box, relays, switches, enclosures, gauges, and so on, are to be assembled together to make an electromechanical device.

Motor as shown in Fig. 8.6 and Miniature Circuit Breaker (MCB) as shown in Fig. 8.7 are also examples of electromechanical assembly.

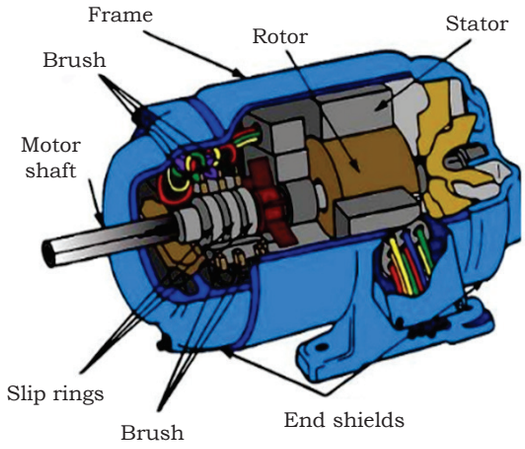

Fig. 8.6 Motor as an electromechanical assembly

Types of assembly

Cabinet assembly

Cabinet assemblies are used in food, pharmaceutical, wastewater treatment and mining industries. Control cabinets provide a compact design for a large number of functions as shown in Fig. 8.9. These serve as decentralised cabinets with all the required components at a specific station to provide identical solutions for identical processes. The control panel as shown in Fig. 8.8 shows an example of cabinet assembly.

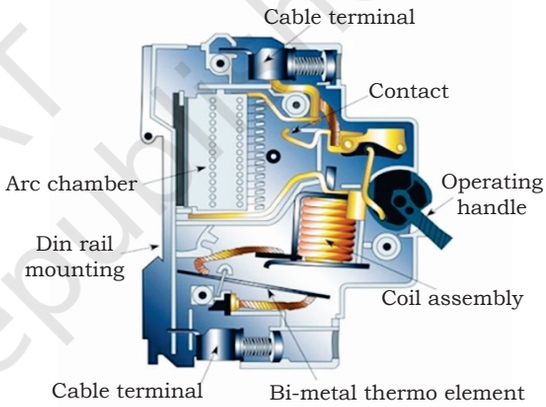

Fig. 8.7 MCB as an electromechanical assembly

Fig. 8.8 Switch gear cabinet in control panel

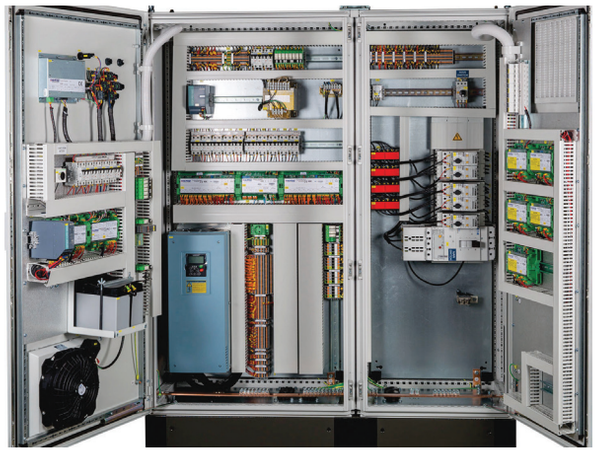

Fig. 8.9 Control cabinet in control panel

Fig.8.10 Motor control centre in control panel

Fig. 8.11 MCC bucket centre assembly in control panel

Bucket assembly

Bucket assemblies are, generally, used for motor control centres (MCC), lever cylinders, and so on. The components of MCC bucket assembly are soft starters, frequency drives, video servers, motor control units, and so on. Figs. 8.10 and 8.11 represent MCC bucket assembly and its internal unit.

Door or shelf assembly

It consists of one or multiple doors to assemble the components. Figs. 8.12 and 8.13 represent door panels.

Cable assembly

In a cable assembly, wires and cables are grouped together to work as a single unit. The number of cables in an assembly depends on the process of wiring. Colour coded wiring is used to locate problems or faulty wires in the cables. Fig. 8.14 represents a cable assembly.

Fig. 8.12 One-door control panel

Fig. 8.13 Multi-door control panel

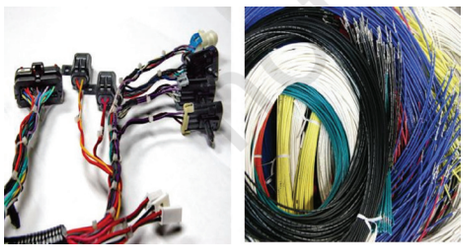

Fig. 8.14 Cable assembly

Wiring instructions and guidelines for assemblies

There are various types of wiring method that can be used for an industrial control panel assembly. The objective is to have a logically arranged panel assembly that is easy to maintain. Following are some of the best

practices that can be followed at the time of control panel assembly wiring.

1. The wires that are used must be of adequate amperage capacity and stranded.
2. Use screws or bolts and not adhesive for anchoring a hinge and wrap the wires running over the hinges.
3. Use the least number of cables or wire ties while wiring, except if it is a temporary one (as shown in Fig. 8.15).

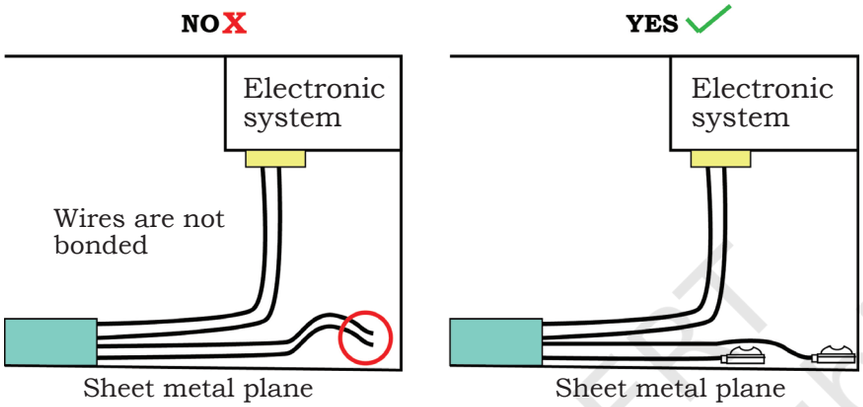

Fig. 8.15 Metal sheet

4. Avoid looping of wires unless needed.
5. Measure the length needed for the wire before cutting it.
6. Always bond the ends of the free conductors.
7. Keep the wire labels in the same direction.
8. Strip the insulation of wires to make joints and connections.
9. Bend and form the bend of a delicate wire gradually.
10. While working with shielded twisted pair cable, strip some amount of the jacket to ensure that every conductor can be accessed for removal and testing.
11. Wires must exit from the terminal without bending.
12. Mount the electrical enclosures cautiously.
13. Eliminate electrostatic discharge by applying appropriate procedure and taking precautions.

14. Considerations for a panel layout are as follows.

    (a) Put Programmable Logic Controller (PLC) input/output (I/O) racks in specified space of the wiring duct so that high-density wires can be easily connected to them. Make sure to route all wires to keep various voltages separated.

    (b) Keep some space between the device and wireways or any other obstruction.
    - Minimum 2 inches for 220V AC and less
    - Minimum 4 inches for 440 Volts

Working with panel assembly

Fig. 8.16(a) Correct raceway (routing) of cable

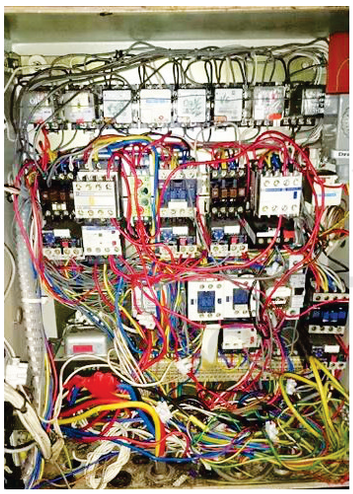

Fig. 8.16(b) Incorrect raceway (routing) of cable

The process of panel assembly includes setting up of side panels, integrating the required components and sub-assemblies on a board, wiring them, putting the board with components in the panel and setting up the wiring according to the wiring diagram. Following points have to be remembered during the panel assembly process.

1. Shielded cables must be used for low-powered signals to ensure less interference.
2. Panels that are conductive in nature, such as steel, must be used. It offers protection against electromagnetic radiation.
3. Use specified connectors and devices to secure the components should be used.
4. Different raceways for different types of cable must be used and precautions be taken while using high and low power devices in the panel to avoid malfunction. Fig. 8.16 (a and b) show correct and incorrect raceways of cables.
    - Prepare the components and enclosures required for assembly operations.
    - Devices, such as frequency converter and variable speed drive, have low radiation within the panel. If they are encapsulated in a metal enclosure, it must be connected to the back side panel, i.e., earthing plane.

- Ensure that the components are not damaged and are free from foreign objects. Dirty cables affect the performance of an appliance, device or equipment adversely.
- Ensure that the tools and equipment are in usable and safe condition and are within the calibration date.
- Do not make loops with cables and wires inside the panels, if not needed. Current flowing through them may create inductive winding. Current identical to the original one will pass through the electrical equipment in the loop. If winding is formed by a power cable, there will be significant amount of energy loss.
- Fig. 8.18 (b) represents the correct way of wiring. Mark the sides of the panels. Do soldering and drilling for attaching the board and components, and for cabling.
- Cut the control wires to the required length, strip the cable insulation, add markers to the wires for easy identification and add ferrules at the ends of the wires.
- Knowledge of approved techniques for mounting electrical components in the panel board and using them safely is required.

Fig. 8.17 Another way of cabling and wiring

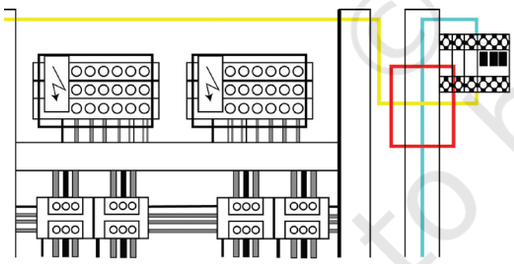

Fig. 8.18(a) Loop of wires

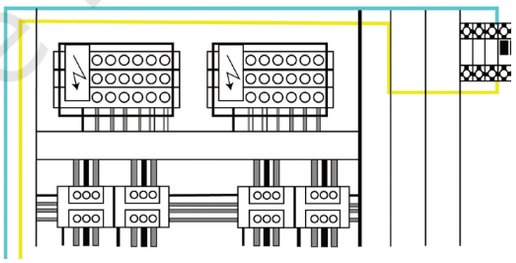

Fig. 8.18(b) Correct way of wiring

- If you use controls, make adjustments or try any procedure other than the specified ones as it may cause an injury. Assemble the components as indicated in the guide. In case of doubt, consult a qualified person.

Note: Ferrule is a cap, usually, made of metal. It is used to shield the cables from external damages and prevent the terminals from splitting.

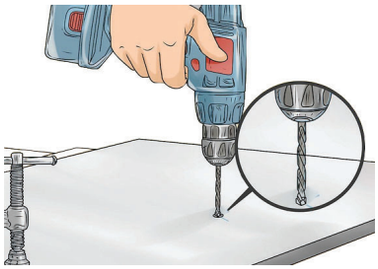

Fig. 8.19 Drilling the panel board

Steps of making panel assembly

The steps of making a panel assembly are as follows.

Step 1

Drill the panel board as shown in Fig. 8.19.

Step 2

Place the components that need to be installed in their respective places as shown in Fig. 8.20. Also, place the power source in its place.

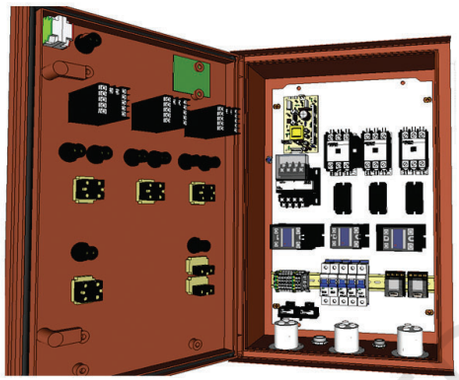

Fig. 8.20 Different components placed on the board

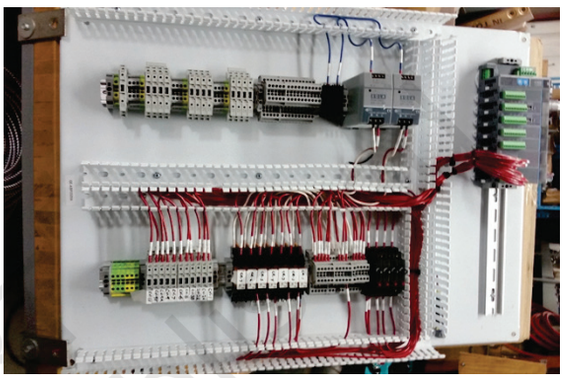

Fig. 8.21 Wireways or cable ways placed on the board

Step 3

Put wire ways or cable ways on the board as per the design and secure them with screws (as shown in Fig. 8.21).

Step 4

Connect the components with wires according to the wiring diagram as shown in Fig. 8.22.

Step 5

Label each component with device tags as shown in Fig. 8.23.

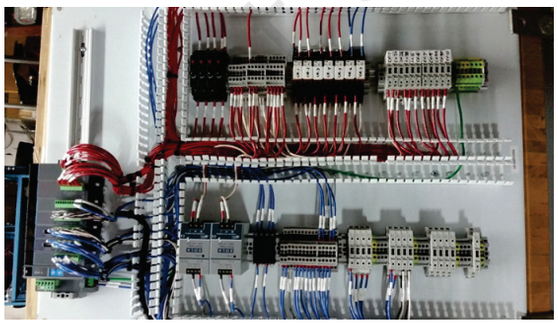

Fig. 8.22 Connect the components with wires

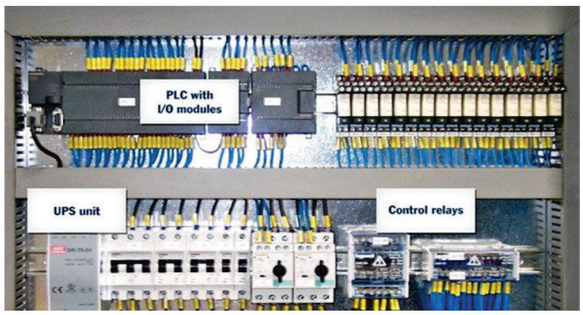

Fig. 8.23 Components with tags

Fig. 8.24 Wires having numbers on the laminated labels

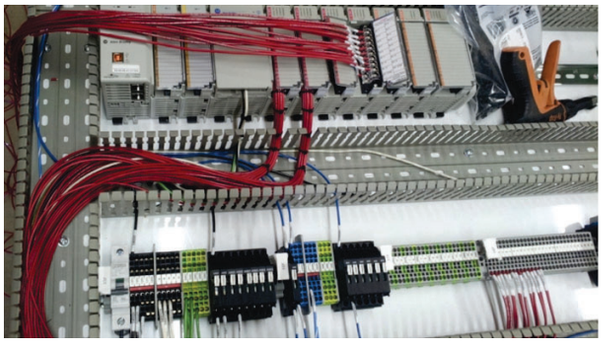

Fig. 8.25 Wires are clipped together

Step 6

Each wire has a number on the label laminated on it as shown in Fig. 8.24. Mark the cable terminals and place the wires and cables on the board in the wireways and cable ways.

Fig. 8.26 Board inside the panel

Step 7

Clip the wires together that run out of the wireways as shown in Fig. 8.25.

Step 8

Place the board integrated with the components inside the panel as shown in Fig. 8.26.

Check Your Progress

A. Multiple choice questions

1. When working at 120V AC, the minimum space between the device and wireways or any other obstruction is _____
   (a) 1 inch
   (b) 2 inches
   (c) 4 inches
   (d) 5 inches
2. Which type of assembly is used in food, pharmaceutical, wastewater treatment and mining industries?
   (a) Cabinet
   (b) Door
   (c) Bucket
   (d) All of the above
3. Name the cap, usually, made of metal that is used to shield cables from external damages and prevent the terminals from splitting.
   (a) Clip
   (b) Clutch

(c) Ferrule
(d) MCB

4. Which of the following cables is used for low-power signals to ensure less interference?
   (a) Unshielded
   (b) Shielded
   (c) Twisted pair
   (d) Coaxial
5. When working at 440V AC, the minimum space between the device and wireways or any other obstruction is _____
   (a) 1 inch
   (b) 2 inches
   (c) 4 inches
   (d) 5 inches
6. Which of the following assemblies are, generally, used for motor control centres (MCC), lever cylinders, etc.?
   (a) Bucket
   (b) Door
   (c) Cabinet
   (d) All of the above
7. MCC stands for _____.
   (a) Motor Control Centre
   (b) Machine Control Centre
   (c) Maintenance Control Centre
   (d) Machine Centre Connection
8. Motor is an example of _____.
   (a) Electrostatic assembly
   (b) Electromechanical assembly
   (c) Electrical assembly
   (d) Electrodynamics assembly
9. PLC stands for _____.
   (a) Programmable Logic Controller
   (b) Programmable Legal Act
   (c) Protect Legal Assembly
   (d) Project Logic Assembly
10. Electromechanical assembly converts _____.
    (a) electrical energy to mechanical movement
    (b) nuclear energy to mechanical movement
    (c) mechanical movement to electrical signal
    (d) Both (a) and (c)

B. Fill in the blanks

1. Strip the wires correctly to make _____.
2. Motor is an example of _____ assembly.
3. While working with _____ cable, strip some amount of the jacket to ensure that every conductor can be accessed for removal and testing.

4. Wires must exit from the terminal without any _____.
5. Mount the _____ enclosures cautiously.
6. Eliminate _____ by applying appropriate procedure and taking precautions.
7. The wires that are used must have adequate _____ capacity and _____.
8. PLC stands for Programmable _____ Controller.
9. Colour coded wire is used to locate _____ in the cable.
10. On each wire, _____ is used for marking.

C. State whether the following statements are True or False

1. Bucket assemblies are used in food, pharmaceutical, wastewater treatment and mining industries.
2. In a cable assembly, wires and cables are grouped together to work as a single unit.
3. Colour coded wiring is used to locate problems or faulty wires in cables.
4. Cabinet assemblies are, generally, used for motor control centres (MCC) and lever cylinders.
5. Ferrule is a cap, usually, made of metal, used to shield cables from external damages and prevent terminals from splitting.
6. Use different raceways for different type of cables and take precautions while using high and low power devices in the panel to avoid malfunction.
7. Avoid looping of wires unless needed.
8. Use screws or bolts and not adhesive for anchoring of hinges and wrapping the wires running over the hinges.

D. Short answer questions

1. What is an electromechanical assembly?
2. List different types of assembly.
3. Discuss the instruction and guidelines followed in the assembly process.
4. What are the components on a panel assembly?
5. List the places where electromechanical assembly is used.
6. What can be the industrial application of electromechanical assembly?

NOTES